ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION (DEPT. OF COMMERCE)

# QUARTERLY PROGRESS REPORT FOR D-REGION IONOSPHERIC PROBE

(NASA Contract R-06-012-007)

March 28 through June 27, 1967

by

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This report describes the work that has been done during the three month period from March 28 through June 27, 1967, on the data from the D-Region Ionospheric Probe launching (NASA Nike-Cajun 10.181). In summary, the trajectory and aspect data have been reduced. The electron density profile from the Faraday rotation experiment has been refined. The Lyman-alpha data has been reduced to obtain Lyman-alpha radiation flux and approximate pressure and collision frequency profiles. Finally, the Gerdien condenser data have been partially reduced to an ion density profile.

The trajectory of the rocket was determined from radar tracking data by a best-fit procedure which will not be described here. The results of this computation are presented in Table 1 in the form of second-by-second values of position (north, east, and vertical components in ft.), velocity (components in ft/sec), and acceleration (components in ft/sec$^2$). The peak of the trajectory occurred at 171.7 sec, at an altitude of 116.4 km (392,000 ft). The position data is all referenced with respect to the launch site (elevation 3989 ft). The first 20 sec of data is not reliable. After payload separation at 270 sec the data describes the Cajun trajectory.

A Heliflux Magnetic Aspect Sensor Type RAM-5C was mounted horizontally in the payload nose section. The device measured the component of the earth's magnetic field along its axis. A DC voltage proportional to projected field intensity drove the even-numbered channels of a 28-channel commutator which in turn fed one of the TM channels.

During the portion of the flight of most interest (40 sec to 172 sec) the rocket was spinning at a steady rate near 8 rps. The maximum and minimum voltage during each spin were measured, and the difference was converted into a projected magnetic field intensity from the instrument calibration. From this the angle between the rocket spin axis and the true magnetic field was computed by assuming a linear change of field with horizontal distance, and an inverse-cube correction for the height variation:

$$B = B_o + \frac{X}{X_{peak}} (B_{peak} - B_o) \left( \frac{R_E}{R_E + Z} \right)^3$$

where $B_o$ = 0.5134 Gauss, $B_{peak}$ = 0.5184 Gauss, and where $X$ = horizontal range, $R_E$ = radius of earth, and $Z$ = altitude.

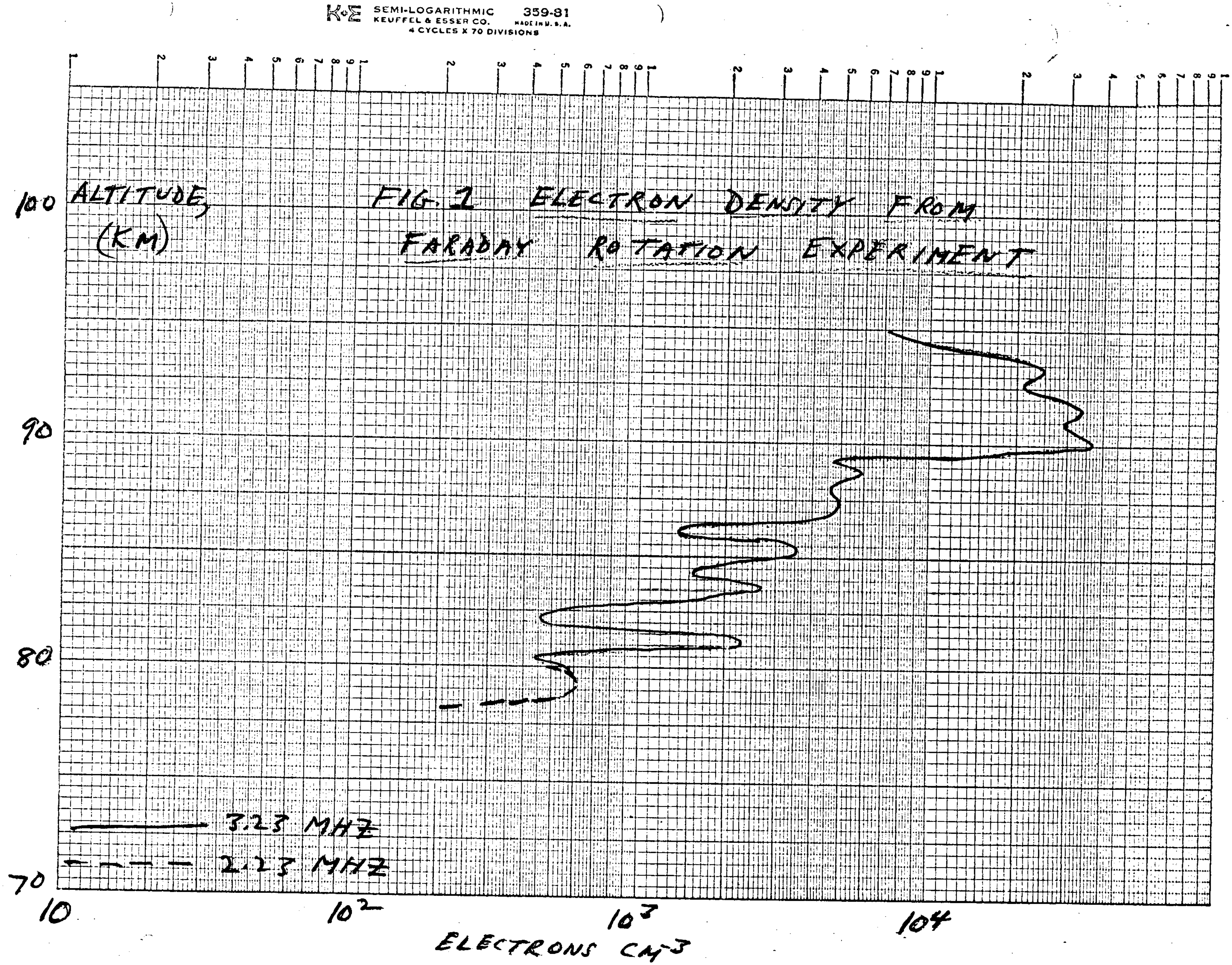
A solar aspect sensor of the Albus type provided the angle between the rocket spin axis and the sun for angles between $19.5^\circ$ and $160^\circ$. This data, read at the same times as the magnetic sensor, was combined with the angle between the spin axis and the magnetic field to provide the azimuth and elevation of the spin axis as a function of time. This information will be provided in the final report.

The preliminary electron density profile from the Faraday rotation experiment which was given in the first quarterly report has been refined as follows: variations in the spin rate of the rocket have been taken into account and measurement errors in the times of the nulls in both the Faraday signals and also in the TM AGC signals have been reduced. The times of the AGC TM nulls were fitted to a smooth curve which was assumed to represent the true spin rate of the rocket. This curve was used as the reference for determining the phase of the Faraday rotation signal. The times of the nulls of the Faraday signals were also fitted to a smooth curve before the phase calculation was made so that individual reading errors in the null times would not be reflected in the final values.

In computing the electron density from the two Faraday rotation frequencies, the quasi-longitudinal approximation of the Appleton-Hartree expression was used. The collision frequency used in the calculation was determined from the Lyman-alpha data. The calculated electron density profile from the two frequencies is shown in Fig. 1.

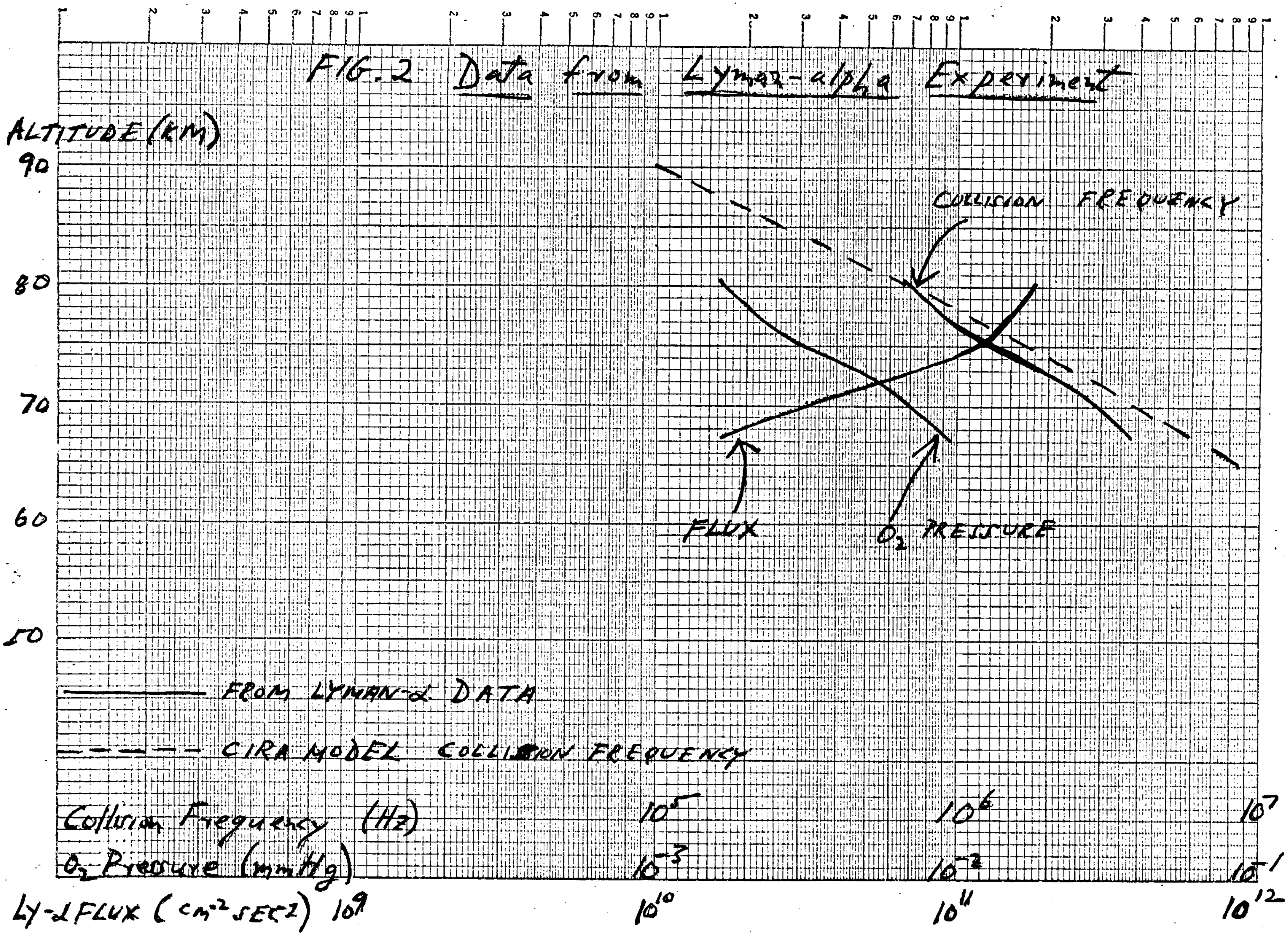
The current measured by the Lyman-alpha ionization chamber was taken to be proportional to the Lyman alpha flux. This flux is shown in Fig. 2 and was determined from the known efficiency of the chamber, the window area, and the angle between the normal to the window and the sun. The partial pressure of $O_2$ is also shown, computed from the Lyman-alpha flux using an absorption cross section of $8.7 \times 10^{-21} cm^2$. From this the electron collision frequency was computed using the relationship of Aikin, Kane, and Troim that the collision frequency is given by $9 \times 10^7$ p (MM Hg) $sec^{-1}$. The actual collision frequency used in the quasi-longitudinal Appleton-Hartree expression was (5/2) times that shown in Fig. 2, as Sen and Wyller have shown.

No useful positive ion data from the positive Gerdien condenser was obtained because of a failure of the bias lead to the instrument. Good data was obtained from the negative ion condenser however. A preliminary calculation of the ion density has been made, based on the assumption that the current is proportional to the number of negative particles (ions and electrons) entering the condenser, the rocket velocity, and the cosine of the angle between the condenser axis and the velocity vector. These assumptions are being examined. It is anticipated that it will be possible to correct these preliminary densities to get a more accurate profile.


K&E SEMI-LOGARITHMIC 359-81
KEUFFEL & ESSER CO. MADE IN U.S.A.
4 CYCLES X 70 DIVISIONS
ALTITUDE, (KM)
FIG. 1 ELECTRON DENSITY FROM FARADAY ROTATION EXPERIMENT
100
90
80
70
10
10^2
10^3
10^4
ELECTRONS CM^-3
3.23 MHZ
2.23 MHZ

K+E SEMI-LOGARITHMIC 359-81
KEUFFEL & ESSER CO. MADE IN U.S.A.
4 CYCLES X 70 DIVISIONS

FIG. 2 Data from Lyman-alpha Experiment



| TIME | NORTH POSITION | NORTH VELOCITY | NORTH ACCELERATION | EAST POSITION | EAST VELOCITY | EAST ACCELERATION | HEIGHT POSITION | HEIGHT VELOCITY | HEIGHT ACCELERATION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1126 | 0 | 0.00 | -100 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1 | 1089 | -128 | -49.74 | -128 | 21 | 18.52 | 755 | 838 | 589.80 |
| 2 | 741 | -149 | 7.16 | -37 | 56 | 9.74 | 2514 | 1769 | 413.45 |
| 3 | 951 | -51 | 20.19 | 24 | 55 | 7.56 | 5152 | 1924 | 359.97 |
| 4 | 380 | 36 | 32.55 | 178 | 49 | 3.40 | 8847 | 2067 | 270.56 |
| 5 | 543 | 94 | 49.28 | 227 | 49 | 0.84 | 10986 | 2347 | 244.23 |
| 6 | 771 | 141 | 66.30 | 286 | 53 | -2.21 | 13466 | 2520 | 150.39 |
| 7 | 1062 | 224 | 70.25 | 318 | 43 | -6.88 | 16038 | 2564 | 39.55 |
| 8 | 1448 | 293 | 59.88 | 338 | 31 | -7.07 | 18605 | 2435 | 12.67 |
| 9 | 1976 | 444 | 49.39 | 339 | 8 | -6.45 | 21122 | 2198 | -13.50 |
| 10 | 2361 | 469 | 40.34 | 349 | 1 | -6.34 | 23434 | 2192 | -54.01 |
| 11 | 2761 | 483 | 34.81 | 350 | -6 | -6.83 | 25594 | 2125 | -78.42 |
| 12 | 3587 | 488 | 25.88 | 300 | -9 | -5.65 | 27068 | 2038 | -83.18 |
| 13 | 4372 | 480 | 14.24 | 246 | -9 | -3.59 | 28629 | 1946 | -55.85 |
| 14 | 4760 | 458 | -5.04 | 237 | -8 | -0.33 | 30710 | 1861 | -13.40 |
| 15 | 5118 | 455 | -4.51 | 228 | -9 | 0.50 | 32594 | 1814 | 1.20 |
| 16 | 5456 | 457 | -1.48 | 241 | -8 | 1.44 | 34377 | 1816 | 29.06 |
| 17 | 5771 | 421 | 3.79 | 254 | -2 | 1.50 | 36117 | 1932 | 64.72 |
| 18 | 6094 | 398 | 11.73 | 263 | 5 | 1.36 | 37870 | 2077 | 105.53 |
| 19 | 6453 | 428 | 21.96 | 272 | 6 | 1.06 | 39760 | 2202 | 148.66 |
| 20 | 6876 | 470 | 30.01 | 279 | 7 | 0.87 | 41936 | 2387 | 187.66 |
| 21 | 7377 | 522 | 36.73 | 284 | 5 | 0.60 | 44460 | 2620 | 217.70 |
| 22 | 7955 | 586 | 46.76 | 287 | 3 | -0.27 | 47326 | 2896 | 229.92 |
| 23 | 8612 | 655 | 54.30 | 288 | 1 | -1.14 | 50532 | 3199 | 234.11 |
| 24 | 9345 | 725 | 54.98 | 287 | -1 | -1.40 | 54076 | 3503 | 235.75 |
| 25 | 10156 | 788 | 53.34 | 285 | -2 | -1.63 | 57959 | 3775 | 226.05 |
| 26 | 11043 | 842 | 49.50 | 280 | -4 | -1.55 | 62177 | 4002 | 206.18 |
| 27 | 11990 | 887 | 43.50 | 273 | -6 | -1.42 | 66659 | 4184 | 177.01 |
| 28 | 12975 | 923 | 36.08 | 265 | -7 | -1.31 | 71286 | 4324 | 141.00 |
| 29 | 13966 | 950 | 28.13 | 256 | -8 | -1.14 | 75911 | 4421 | 102.63 |
| 30 | 14954 | 968 | 20.84 | 247 | -9 | -1.00 | 80476 | 4476 | 67.34 |
| 31 | 15938 | 977 | 14.54 | 236 | -10 | -0.85 | 84986 | 4489 | 37.45 |
| 32 | 16917 | 980 | 9.31 | 226 | -11 | -0.72 | 89450 | 4468 | 12.67 |
| 33 | 17893 | 978 | 5.13 | 215 | -11 | -0.64 | 93868 | 4427 | -7.23 |
| 34 | 18866 | 975 | 1.98 | 203 | -11 | -0.57 | 98242 | 4381 | -22.34 |
| 35 | 19839 | 973 | -0.33 | 191 | -12 | -0.53 | 102575 | 4339 | -33.28 |
| 36 | 20809 | 971 | -1.88 | 178 | -12 | -0.49 | 106868 | 4298 | -39.95 |
| 37 | 21777 | 969 | -2.77 | 166 | -13 | -0.42 | 111125 | 4259 | -43.34 |
| 38 | 22744 | 968 | -3.39 | 153 | -13 | -0.37 | 115342 | 4220 | -45.19 |
| 39 | 23709 | 965 | -3.66 | 141 | -14 | -0.26 | 119525 | 4176 | -45.88 |
| 40 | 24674 | 960 | -3.37 | 127 | -14 | -0.29 | 123672 | 4129 | -44.78 |
| 41 | 25638 | 955 | -3.22 | 112 | -14 | -0.29 | 127781 | 4078 | -44.05 |
| 42 | 26601 | 947 | -3.06 | 96 | -14 | -0.26 | 131850 | 4020 | -43.35 |
| 43 | 27550 | 942 | -2.93 | 79 | -14 | -0.23 | 135829 | 3968 | -42.53 |
| 44 | 28482 | 942 | -2.31 | 62 | -14 | -0.15 | 139736 | 3936 | -39.74 |
| 45 | 29403 | 942 | -1.13 | 48 | -15 | -0.05 | 143567 | 3902 | -35.67 |
| 46 | 30304 | 942 | 0.42 | 37 | -15 | -0.12 | 147304 | 3869 | -30.00 |
| 47 | 31225 | 941 | 2.73 | 29 | -15 | -0.29 | 151057 | 3837 | -22.17 |
| 48 | 32191 | 944 | 4.22 | 11 | -15 | -0.62 | 154946 | 3819 | -16.17 |
| 49 | 33150 | 950 | 4.08 | -7 | -15 | -0.58 | 158790 | 3808 | -16.50 |
| 50 | 34112 | 959 | 4.15 | -23 | -15 | -0.53 | 162602 | 3808 | -16.36 |
| 51 | 35072 | 972 | 4.12 | -41 | -17 | -0.55 | 166387 | 3820 | -16.28 |
| 52 | 36046 | 980 | 4.15 | -57 | -19 | -0.57 | 170196 | 3823 | -16.44 |
| 53 | 37033 | 979 | 3.62 | -71 | -20 | -0.65 | 174009 | 3787 | -18.73 |
| 54 | 38032 | 979 | 2.58 | -91 | -20 | -0.78 | 177835 | 3755 | -22.37 |
| 55 | 39051 | 979 | 1.11 | -116 | -20 | -0.71 | 181688 | 3722 | -27.69 |
| 56 | 40049 | 979 | -1.16 | -145 | -20 | -0.52 | 185461 | 3689 | -35.19 |
| 57 | 41003 | 977 | -2.61 | -165 | -21 | -0.16 | 189032 | 3650 | -40.95 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 58 | 41962 | 973 | -2.48 | -182 | -22 | -0.17 | 192583 | 3607 | -40.41 |
| 59 | 42919 | 969 | -2.49 | -203 | -22 | -0.27 | 196104 | 3558 | -40.37 |
| 60 | 43879 | 962 | -2.50 | -224 | -22 | -0.23 | 199592 | 3504 | -40.33 |
| 61 | 44836 | 957 | -2.57 | -245 | -21 | -0.21 | 203047 | 3454 | -40.20 |
| 62 | 45793 | 957 | -2.39 | -267 | -21 | -0.18 | 206470 | 3424 | -39.33 |
| 63 | 46750 | 957 | -2.09 | -288 | -22 | -0.12 | 209861 | 3391 | -38.05 |
| 64 | 47705 | 956 | -1.59 | -311 | -22 | -0.15 | 213220 | 3359 | -36.18 |
| 65 | 48660 | 955 | -0.76 | -332 | -22 | -0.24 | 216548 | 3328 | -33.62 |
| 66 | 49615 | 955 | -0.26 | -355 | -23 | -0.39 | 219844 | 3296 | -31.64 |
| 67 | 50572 | 955 | -0.25 | -380 | -23 | -0.40 | 223107 | 3264 | -31.75 |
| 68 | 51524 | 954 | -0.29 | -402 | -23 | -0.32 | 226339 | 3233 | -31.67 |
| 69 | 52478 | 955 | -0.12 | -425 | -24 | -0.37 | 229541 | 3201 | -31.65 |
| 70 | 53432 | 954 | -0.04 | -448 | -24 | -0.39 | 232711 | 3169 | -31.62 |
| 71 | 54384 | 955 | -0.01 | -473 | -25 | -0.42 | 235849 | 3138 | -31.64 |
| 72 | 55339 | 954 | 0.16 | -498 | -25 | -0.42 | 238955 | 3106 | -31.63 |
| 73 | 56297 | 955 | 0.18 | -525 | -25 | -0.43 | 242029 | 3075 | -31.61 |
| 74 | 57251 | 955 | 0.05 | -550 | -26 | -0.37 | 245072 | 3043 | -31.57 |
| 75 | 58206 | 955 | 0.16 | -577 | -26 | -0.33 | 248084 | 3011 | -31.54 |
| 76 | 59158 | 956 | 0.15 | -603 | -27 | -0.32 | 251064 | 2980 | -31.54 |
| 77 | 60119 | 956 | 0.27 | -630 | -27 | -0.34 | 254011 | 2948 | -31.55 |
| 78 | 61073 | 955 | 0.04 | -658 | -27 | -0.27 | 256928 | 2917 | -31.47 |
| 79 | 62028 | 956 | 0.12 | -685 | -27 | -0.22 | 259813 | 2885 | -31.46 |
| 80 | 62988 | 956 | 0.16 | -712 | -28 | -0.17 | 262666 | 2854 | -31.42 |
| 81 | 63943 | 956 | 0.07 | -742 | -28 | -0.21 | 265489 | 2822 | -31.38 |
| 82 | 64893 | 955 | 0.01 | -770 | -28 | -0.17 | 268282 | 2791 | -31.35 |
| 83 | 65854 | 956 | 0.25 | -795 | -28 | -0.20 | 271041 | 2760 | -31.39 |
| 84 | 66810 | 957 | 0.08 | -825 | -28 | -0.32 | 273770 | 2729 | -31.38 |
| 85 | 67766 | 957 | 0.08 | -854 | -29 | -0.24 | 276466 | 2697 | -31.36 |
| 86 | 68718 | 956 | -0.02 | -881 | -29 | -0.20 | 279133 | 2666 | -31.31 |
| 87 | 69678 | 957 | 0.09 | -908 | -29 | -0.22 | 281768 | 2634 | -31.33 |
| 88 | 70636 | 957 | -0.13 | -937 | -30 | -0.31 | 284370 | 2603 | -31.30 |
| 89 | 71597 | 957 | -0.28 | -969 | -30 | -0.37 | 286941 | 2572 | -31.28 |
| 90 | 72547 | 956 | -0.47 | -999 | -30 | -0.29 | 289484 | 2541 | -31.22 |
| 91 | 73509 | 956 | -0.31 | -1030 | -30 | -0.27 | 291991 | 2509 | -31.27 |
| 92 | 74464 | 955 | -0.59 | -1066 | -31 | -0.29 | 294469 | 2478 | -31.19 |
| 93 | 75419 | 954 | -0.59 | -1093 | -31 | -0.06 | 296915 | 2447 | -31.15 |
| 94 | 76372 | 952 | -0.70 | -1121 | -31 | -0.19 | 299332 | 2416 | -31.11 |
| 95 | 77324 | 953 | -0.57 | -1150 | -31 | -0.27 | 301718 | 2385 | -31.16 |
| 96 | 78272 | 952 | -0.53 | -1183 | -32 | -0.35 | 304072 | 2354 | -31.18 |
| 97 | 79223 | 951 | -0.26 | -1218 | -31 | -0.29 | 306394 | 2323 | -31.22 |
| 98 | 80168 | 950 | -0.18 | -1249 | -31 | -0.17 | 308687 | 2292 | -31.20 |
| 99 | 81126 | 951 | 0.17 | -1279 | -32 | -0.14 | 310945 | 2260 | -31.30 |
| 100 | 82077 | 951 | 0.04 | -1314 | -33 | -0.22 | 313174 | 2229 | -31.26 |
| 101 | 83026 | 953 | 0.22 | -1342 | -33 | -0.03 | 315373 | 2197 | -31.30 |
| 102 | 83973 | 952 | 0.33 | -1376 | -33 | -0.26 | 317541 | 2166 | -31.32 |
| 103 | 84932 | 954 | 0.48 | -1410 | -32 | -0.22 | 319674 | 2134 | -31.37 |
| 104 | 85888 | 954 | 0.19 | -1447 | -33 | -0.13 | 321777 | 2103 | -31.26 |
| 105 | 86845 | 954 | 0.11 | -1482 | -32 | 0.02 | 323847 | 2072 | -31.22 |
| 106 | 87794 | 954 | -0.16 | -1513 | -33 | 0.02 | 325890 | 2041 | -31.13 |
| 107 | 88753 | 955 | 0.08 | -1541 | -33 | -0.12 | 327897 | 2009 | -31.22 |
| 108 | 89709 | 953 | -0.33 | -1575 | -33 | -0.34 | 329875 | 1979 | -31.05 |
| 109 | 90663 | 952 | -0.35 | -1600 | -33 | -0.32 | 331822 | 1948 | -31.03 |
| 110 | 91615 | 951 | -0.52 | -1639 | -33 | -0.58 | 333740 | 1917 | -30.95 |
| 111 | 92565 | 953 | -0.50 | -1676 | -34 | -0.38 | 335626 | 1885 | -31.00 |
| 112 | 93508 | 951 | -0.45 | -1710 | -35 | -0.29 | 337484 | 1855 | -30.99 |
| 113 | 94460 | 950 | -0.04 | -1743 | -36 | -0.34 | 339306 | 1824 | -31.12 |
| 114 | 95405 | 949 | -0.05 | -1778 | -37 | -0.43 | 341101 | 1793 | -31.08 |
| 115 | 96372 | 950 | 0.22 | -1818 | -36 | -0.37 | 342858 | 1762 | -31.17 |
| 116 | 97311 | 951 | -0.43 | -1860 | -36 | -0.21 | 344592 | 1731 | -30.96 |
| 117 | 98263 | 952 | 0.04 | -1898 | -36 | 0.03 | 346291 | 1699 | -31.14 |
| 118 | 99207 | 952 | -0.04 | -1934 | -37 | 0.12 | 347963 | 1668 | -31.12 |
| 119 | 100163 | 953 | 0.23 | -1967 | -36 | 0.07 | 349596 | 1637 | -31.27 |
| 120 | 101120 | 949 | -0.04 | -2000 | -36 | -0.09 | 351201 | 1607 | -31.13 |
| 121 | 102080 | 951 | -0.12 | -2037 | -35 | -0.27 | 352772 | 1575 | -31.13 |
| 122 | 103027 | 950 | -0.54 | -2073 | -35 | -0.17 | 354319 | 1544 | -30.98 |
| 123 | 103983 | 951 | -0.53 | -2105 | -36 | -0.26 | 355830 | 1512 | -31.06 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 124 | 104914 | 950 | -0.85 | -2140 | -37 | -0.36 | 357317 | 1482 | -30.94 |
| 125 | 105872 | 949 | -0.09 | -2176 | -38 | -0.37 | 358765 | 1450 | -31.18 |
| 126 | 106815 | 948 | -0.49 | -2211 | -38 | -0.42 | 360187 | 1420 | -31.02 |
| 127 | 107769 | 947 | -0.26 | -2262 | -39 | -0.46 | 361571 | 1389 | -31.11 |
| 128 | 108709 | 945 | -0.49 | -2302 | -40 | 0.13 | 362931 | 1358 | -30.91 |
| 129 | 109665 | 948 | -0.21 | -2347 | -39 | 0.25 | 364254 | 1326 | -31.04 |
| 130 | 110608 | 947 | -0.44 | -2378 | -39 | 0.60 | 365551 | 1296 | -30.91 |
| 131 | 111552 | 948 | -0.14 | -2425 | -39 | 0.42 | 366815 | 1264 | -31.02 |
| 132 | 112491 | 947 | -0.09 | -2461 | -35 | 0.81 | 368052 | 1234 | -30.96 |
| 133 | 113449 | 948 | 0.29 | -2492 | -35 | 0.85 | 369252 | 1202 | -31.11 |
| 134 | 114394 | 945 | -0.26 | -2527 | -33 | 0.68 | 370425 | 1172 | -30.94 |
| 135 | 115345 | 946 | -0.12 | -2561 | -34 | 0.65 | 371563 | 1141 | -31.01 |
| 136 | 116292 | 946 | -0.39 | -2580 | -32 | 0.60 | 372675 | 1110 | -30.88 |
| 137 | 117237 | 948 | -0.25 | -2616 | -32 | -0.16 | 373752 | 1078 | -31.00 |
| 138 | 118174 | 946 | -0.34 | -2644 | -33 | -0.19 | 374803 | 1048 | -30.90 |
| 139 | 119125 | 946 | 0.06 | -2685 | -33 | -0.56 | 375817 | 1016 | -31.03 |
| 140 | 120070 | 944 | -0.19 | -2711 | -33 | -0.39 | 376804 | 986 | -30.91 |
| 141 | 121024 | 945 | -0.20 | -2748 | -37 | -0.78 | 377755 | 955 | -30.95 |
| 142 | 121963 | 945 | -0.46 | -2788 | -37 | -0.87 | 378680 | 924 | -30.82 |
| 143 | 122905 | 946 | -0.01 | -2824 | -38 | -0.79 | 379573 | 893 | -30.95 |
| 144 | 123844 | 945 | 0.19 | -2863 | -38 | -0.77 | 380437 | 862 | -30.97 |
| 145 | 124794 | 945 | 0.42 | -2910 | -39 | -0.76 | 381267 | 831 | -31.09 |
| 146 | 125739 | 944 | 0.27 | -2946 | -40 | -0.26 | 382070 | 801 | -31.03 |
| 147 | 126688 | 946 | 0.49 | -2987 | -40 | -0.14 | 382838 | 769 | -31.20 |
| 148 | 127627 | 947 | 0.24 | -3024 | -40 | 0.15 | 383579 | 738 | -31.15 |
| 149 | 128571 | 948 | 0.43 | -3060 | -40 | 0.17 | 384286 | 706 | -31.25 |
| 150 | 129518 | 947 | 0.47 | -3107 | -39 | 0.33 | 384961 | 675 | -31.24 |
| 151 | 130476 | 949 | 0.36 | -3149 | -38 | 0.66 | 385601 | 643 | -31.21 |
| 152 | 131432 | 948 | -0.16 | -3184 | -37 | 0.76 | 386212 | 612 | -31.02 |
| 153 | 132377 | 948 | -0.57 | -3226 | -36 | 0.83 | 386794 | 581 | -30.90 |
| 154 | 133319 | 949 | -0.70 | -3262 | -36 | 0.95 | 387346 | 550 | -30.83 |
| 155 | 134279 | 947 | -0.45 | -3287 | -34 | 0.91 | 387860 | 520 | -30.90 |
| 156 | 135222 | 944 | -0.98 | -3318 | -33 | 0.57 | 388350 | 490 | -30.65 |
| 157 | 136163 | 942 | -0.81 | -3348 | -33 | 0.37 | 388810 | 460 | -30.69 |
| 158 | 137110 | 942 | -0.82 | -3384 | -32 | 0.22 | 389238 | 429 | -30.67 |
| 159 | 138042 | 943 | -1.08 | -3411 | -31 | 0.27 | 389640 | 397 | -30.60 |
| 160 | 138977 | 940 | -0.62 | -3448 | -33 | -0.02 | 390009 | 368 | -30.79 |
| 161 | 139913 | 941 | -0.09 | -3477 | -33 | -0.12 | 390347 | 336 | -31.01 |
| 162 | 140854 | 941 | 0.41 | -3511 | -34 | -0.36 | 390653 | 305 | -31.21 |
| 163 | 141807 | 939 | 0.34 | -3539 | -33 | -0.35 | 390922 | 275 | -31.19 |
| 164 | 142740 | 941 | -0.05 | -3583 | -34 | -0.63 | 391168 | 243 | -31.06 |
| 165 | 143690 | 944 | 0.36 | -3619 | -34 | -0.33 | 391376 | 211 | -31.25 |
| 166 | 144633 | 946 | 0.15 | -3655 | -36 | -0.26 | 391556 | 179 | -31.14 |
| 167 | 145562 | 945 | 0.22 | -3685 | -35 | -0.20 | 391711 | 148 | -31.19 |
| 168 | 146515 | 943 | 0.93 | -3717 | -36 | -0.61 | 391824 | 118 | -31.48 |
| 169 | 147469 | 943 | 0.57 | -3756 | -36 | -0.76 | 391906 | 86 | -31.37 |
| 170 | 148427 | 942 | 0.04 | -3799 | -36 | -0.71 | 391955 | 56 | -31.27 |
| 171 | 149357 | 943 | -0.64 | -3826 | -36 | -0.49 | 391986 | 24 | -31.05 |
| 172 | 150291 | 947 | -0.24 | -3868 | -39 | -0.80 | 391982 | -8 | -31.25 |
| 173 | 151231 | 947 | 0.11 | -3905 | -41 | -0.53 | 391945 | -40 | -31.35 |
| 174 | 152171 | 944 | 0.08 | -3941 | -41 | -0.53 | 391879 | -71 | -31.33 |
| 175 | 153121 | 940 | 0.28 | -3979 | -40 | -0.69 | 391777 | -101 | -31.46 |
| 176 | 154089 | 943 | -0.12 | -4035 | -42 | -0.75 | 391635 | -133 | -31.28 |
| 177 | 155034 | 944 | -1.04 | -4086 | -41 | 0.00 | 391467 | -164 | -30.87 |
| 178 | 155965 | 944 | -1.05 | -4121 | -41 | 0.59 | 391269 | -196 | -30.69 |
| 179 | 156890 | 945 | -0.58 | -4162 | -42 | 0.62 | 391047 | -227 | -30.50 |
| 180 | 157842 | 942 | 0.00 | -4205 | -43 | 0.75 | 390787 | -257 | -30.54 |
| 181 | 158783 | 938 | -0.49 | -4238 | -39 | 1.13 | 390503 | -286 | -30.29 |
| 182 | 159728 | 937 | -0.67 | -4270 | -36 | 1.07 | 390185 | -316 | -30.25 |
| 183 | 160673 | 939 | -0.77 | -4318 | -35 | 1.05 | 389835 | -345 | -30.29 |
| 184 | 161600 | 940 | -1.13 | -4363 | -34 | 1.57 | 389463 | -376 | -29.99 |
| 185 | 162532 | 938 | -0.48 | -4385 | -32 | 1.85 | 389058 | -406 | -30.28 |
| 186 | 163468 | 938 | 0.00 | -4406 | -32 | 1.26 | 388625 | -437 | -30.53 |
| 187 | 164414 | 937 | 0.06 | -4436 | -31 | 0.57 | 388161 | -467 | -30.72 |
| 188 | 165353 | 935 | -0.43 | -4463 | -28 | 0.59 | 387665 | -497 | -30.88 |
| 189 | 166287 | 938 | -0.69 | -4492 | -26 | 0.32 | 387136 | -530 | -30.95 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 190 | 167222 | 938 | -0.30 | -4522 | -28 | -0.01 | 386573 | -561 | -31.19 |
| 191 | 168162 | 938 | -0.27 | -4551 | -30 | -0.20 | 385978 | -592 | -31.17 |
| 192 | 169085 | 935 | -0.40 | -4569 | -30 | -0.45 | 385361 | -623 | -31.12 |
| 193 | 170039 | 934 | 0.09 | -4598 | -31 | -1.15 | 384697 | -654 | -31.40 |
| 194 | 170976 | 936 | -0.59 | -4634 | -32 | -1.47 | 384008 | -686 | -31.10 |
| 195 | 171908 | 935 | -0.89 | -4680 | -33 | -1.39 | 383293 | -717 | -30.89 |
| 196 | 172828 | 934 | -0.88 | -4703 | -35 | -0.94 | 382553 | -747 | -30.86 |
| 197 | 173760 | 935 | -0.47 | -4739 | -38 | -1.42 | 381776 | -780 | -30.95 |
| 198 | 174709 | 932 | -0.41 | -4781 | -39 | -1.19 | 380957 | -809 | -30.91 |
| 199 | 175638 | 930 | -0.90 | -4823 | -40 | -1.02 | 380119 | -839 | -30.63 |
| 200 | 176565 | 930 | -0.81 | -4868 | -39 | -0.75 | 379251 | -870 | -30.70 |
| 201 | 177504 | 931 | -0.57 | -4912 | -42 | -0.43 | 378344 | -902 | -30.83 |
| 202 | 178431 | 930 | -0.98 | -4951 | -41 | 0.10 | 377412 | -933 | -30.56 |
| 203 | 179348 | 928 | -0.69 | -4995 | -41 | 0.27 | 376456 | -962 | -30.69 |
| 204 | 180276 | 928 | -0.11 | -5031 | -40 | 0.61 | 375462 | -993 | -31.02 |
| 205 | 181205 | 928 | 0.00 | -5084 | -39 | 0.58 | 374437 | -1025 | -31.08 |
| 206 | 182133 | 927 | 0.06 | -5111 | -37 | 1.47 | 373382 | -1055 | -31.10 |
| 207 | 183057 | 926 | 0.23 | -5151 | -37 | 1.19 | 372298 | -1086 | -31.24 |
| 208 | 183989 | 929 | 0.70 | -5184 | -35 | 1.43 | 371178 | -1118 | -31.52 |
| 209 | 184920 | 930 | 0.74 | -5219 | -34 | 1.46 | 370026 | -1150 | -31.55 |
| 210 | 185843 | 931 | 0.71 | -5248 | -29 | 1.47 | 368851 | -1182 | -31.51 |
| 211 | 186767 | 932 | 1.00 | -5283 | -31 | 1.32 | 367641 | -1214 | -31.77 |
| 212 | 187710 | 934 | 1.06 | -5306 | -28 | 1.45 | 366391 | -1246 | -31.80 |
| 213 | 188645 | 935 | 0.48 | -5334 | -27 | 1.14 | 365114 | -1277 | -31.48 |
| 214 | 189586 | 935 | 0.35 | -5347 | -26 | 1.04 | 363802 | -1309 | -31.43 |
| 215 | 190526 | 936 | -0.05 | -5386 | -25 | 0.22 | 362458 | -1341 | -31.22 |
| 216 | 191461 | 936 | -0.40 | -5406 | -24 | 0.52 | 361086 | -1372 | -30.98 |
| 217 | 192399 | 933 | -0.68 | -5427 | -24 | 0.13 | 359682 | -1402 | -30.81 |
| 218 | 193333 | 933 | -1.08 | -5452 | -24 | -0.20 | 358249 | -1433 | -30.58 |
| 219 | 194264 | 931 | -1.26 | -5476 | -27 | -0.33 | 356785 | -1463 | -30.51 |
| 220 | 195189 | 929 | -1.43 | -5496 | -26 | -0.45 | 355295 | -1493 | -30.32 |
| 221 | 196111 | 928 | -1.41 | -5525 | -27 | -0.94 | 353775 | -1523 | -30.32 |
| 222 | 197042 | 925 | -1.11 | -5554 | -29 | -0.82 | 352219 | -1553 | -30.49 |
| 223 | 197962 | 923 | -1.01 | -5591 | -29 | -0.64 | 350638 | -1583 | -30.54 |
| 224 | 198885 | 923 | -0.62 | -5619 | -29 | -0.30 | 349024 | -1614 | -30.78 |
| 225 | 199810 | 923 | -0.30 | -5651 | -32 | -0.31 | 347378 | -1645 | -31.00 |
| 226 | 200722 | 924 | -0.28 | -5686 | -32 | -0.03 | 345709 | -1676 | -31.02 |
| 227 | 201645 | 924 | 0.33 | -5711 | -30 | 0.26 | 344001 | -1708 | -31.40 |
| 228 | 202569 | 925 | 0.50 | -5742 | -30 | 0.25 | 342264 | -1740 | -31.45 |
| 229 | 203496 | 926 | 0.71 | -5786 | -29 | 0.44 | 340492 | -1772 | -31.68 |
| 230 | 204423 | 925 | 0.63 | -5811 | -27 | 1.14 | 338690 | -1802 | -31.67 |
| 231 | 205357 | 928 | 0.75 | -5826 | -26 | 1.11 | 336851 | -1835 | -31.81 |
| 232 | 206288 | 928 | 0.49 | -5860 | -27 | 0.77 | 334981 | -1866 | -31.66 |
| 233 | 207220 | 929 | 0.20 | -5878 | -26 | 1.07 | 333079 | -1899 | -31.45 |
| 234 | 208137 | 929 | 0.05 | -5898 | -22 | 0.78 | 331158 | -1930 | -31.33 |
| 235 | 209072 | 930 | 0.30 | -5924 | -22 | 0.64 | 329192 | -1962 | -31.51 |
| 236 | 209996 | 928 | -0.08 | -5949 | -23 | 0.57 | 327205 | -1993 | -31.29 |
| 237 | 210931 | 927 | -0.03 | -5971 | -20 | 0.65 | 325176 | -2023 | -31.39 |
| 238 | 211855 | 927 | -0.26 | -5984 | -22 | 0.49 | 323124 | -2054 | -31.20 |
| 239 | 212795 | 928 | -0.20 | -6006 | -22 | 0.13 | 321028 | -2086 | -31.24 |
| 240 | 213712 | 927 | -0.60 | -6036 | -21 | 0.18 | 318918 | -2117 | -30.94 |
| 241 | 214631 | 928 | -0.40 | -6041 | -21 | 0.53 | 316777 | -2149 | -31.08 |
| 242 | 215559 | 927 | -0.14 | -6073 | -21 | 0.07 | 314597 | -2180 | -31.30 |
| 243 | 216489 | 927 | -0.33 | -6093 | -21 | 0.53 | 312385 | -2211 | -31.20 |
| 244 | 217416 | 925 | -0.53 | -6116 | -20 | 0.62 | 310142 | -2241 | -31.10 |
| 245 | 218345 | 925 | -0.50 | -6135 | -19 | 0.80 | 307866 | -2272 | -31.13 |
| 246 | 219272 | 926 | -0.68 | -6161 | -20 | 0.84 | 305560 | -2304 | -30.97 |
| 247 | 220198 | 924 | -0.70 | -6171 | -17 | 1.12 | 303224 | -2334 | -30.96 |
| 248 | 221118 | 923 | -0.75 | -6188 | -16 | 1.02 | 300860 | -2366 | -30.95 |
| 249 | 222035 | 923 | -0.50 | -6202 | -14 | 1.01 | 298468 | -2397 | -31.12 |
| 250 | 222962 | 922 | -0.40 | -6218 | -13 | 0.95 | 296037 | -2428 | -31.23 |
| 251 | 223872 | 920 | -0.49 | -6226 | -11 | 1.06 | 293586 | -2458 | -31.19 |
| 252 | 224797 | 920 | -0.09 | -6238 | -12 | 0.71 | 291093 | -2490 | -31.47 |
| 253 | 225719 | 920 | -0.03 | -6243 | -11 | 0.66 | 288570 | -2521 | -31.51 |
| 254 | 226639 | 921 | -0.05 | -6253 | -10 | 0.40 | 286018 | -2553 | -31.50 |
| 255 | 227556 | 921 | 0.07 | -6260 | -10 | 0.27 | 283436 | -2585 | -31.61 |

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|---|---|---|---|---|---|---|---|---|---|
| 322 | 284670 | 533 | -30.46 | -5992 | 17 | -0.68 | 55625 | -2881 | 130.30 |
| 323 | 285172 | 501 | -31.25 | -5978 | 17 | -0.59 | 52872 | -2737 | 135.64 |
| 324 | 285642 | 468 | -31.73 | -5960 | 17 | -0.50 | 50271 | -2593 | 139.37 |
| 325 | 286076 | 435 | -31.78 | -5944 | 16 | -0.59 | 47823 | -2448 | 140.77 |
| 326 | 286477 | 403 | -31.57 | -5929 | 15 | -0.59 | 45530 | -2302 | 140.88 |
| 327 | 286845 | 371 | -30.73 | -5914 | 15 | -0.62 | 43388 | -2159 | 137.70 |
| 328 | 287181 | 340 | -29.80 | -5899 | 14 | -0.72 | 41392 | -2019 | 133.83 |
| 329 | 287485 | 311 | -28.64 | -5887 | 13 | -0.84 | 39533 | -1886 | 128.89 |
| 330 | 287760 | 283 | -27.23 | -5875 | 13 | -0.83 | 37805 | -1760 | 122.84 |
| 331 | 288010 | 257 | -25.64 | -5860 | 12 | -0.83 | 36197 | -1642 | 115.72 |
| 332 | 288236 | 233 | -23.96 | -5850 | 10 | -1.02 | 34697 | -1533 | 107.83 |
| 333 | 288439 | 210 | -22.19 | -5839 | 9 | -1.07 | 33297 | -1433 | 99.51 |
| 334 | 288623 | 190 | -20.38 | -5830 | 8 | -1.13 | 31984 | -1342 | 90.98 |
| 335 | 288788 | 172 | -18.62 | -5825 | 7 | -1.16 | 30754 | -1261 | 82.52 |
| 336 | 288938 | 156 | -16.91 | -5821 | 6 | -1.10 | 29592 | -1168 | 74.19 |
| 337 | 289074 | 141 | -15.31 | -5817 | 5 | -1.03 | 28495 | -1124 | 66.34 |
| 338 | 289198 | 127 | -13.82 | -5813 | 3 | -0.89 | 27454 | -1067 | 58.89 |
| 339 | 289310 | 115 | -12.50 | -5809 | 2 | -0.86 | 26458 | -1017 | 51.95 |
| 340 | 289411 | 105 | -11.33 | -5811 | 2 | -0.82 | 25502 | -974 | 45.76 |
| 341 | 289502 | 95 | -10.23 | -5808 | 1 | -0.62 | 24583 | -936 | 40.20 |
| 342 | 289585 | 86 | -9.30 | -5809 | 1 | -0.57 | 23692 | -903 | 35.28 |
| 343 | 289661 | 78 | -8.49 | -5811 | 0 | -0.41 | 22830 | -875 | 31.19 |
| 344 | 289730 | 70 | -7.80 | -5811 | -0 | -0.27 | 21988 | -849 | 27.50 |
| 345 | 289791 | 63 | -7.19 | -5811 | -0 | -0.22 | 21170 | -826 | 24.48 |
| 346 | 289848 | 57 | -6.66 | -5809 | -0 | -0.17 | 20369 | -806 | 21.85 |
| 347 | 289898 | 51 | -6.24 | -5809 | -0 | -0.21 | 19583 | -786 | 19.76 |
| 348 | 289942 | 45 | -5.86 | -5810 | -0 | -0.17 | 18817 | -770 | 18.09 |
| 349 | 289982 | 40 | -5.49 | -5811 | -0 | -0.12 | 18064 | -754 | 16.60 |
| 350 | 290015 | 35 | -5.19 | -5812 | -0 | -0.14 | 17327 | -739 | 15.41 |
| 351 | 290044 | 30 | -4.89 | -5813 | -1 | -0.12 | 16614 | -725 | 14.38 |
| 352 | 290068 | 25 | -4.58 | -5813 | -1 | -0.13 | 15903 | -712 | 13.11 |
| 353 | 290089 | 21 | -4.27 | -5813 | -1 | -0.17 | 15205 | -700 | 12.34 |
| 354 | 290105 | 17 | -3.99 | -5814 | -1 | -0.19 | 14518 | -688 | 11.61 |
| 355 | 290116 | 13 | -3.70 | -5817 | -2 | -0.19 | 13843 | -677 | 11.02 |
| 356 | 290124 | 10 | -3.36 | -5819 | -2 | -0.14 | 13178 | -669 | 10.44 |
| 357 | 290130 | 7 | -3.02 | -5820 | -2 | -0.14 | 12521 | -659 | 9.92 |
| 358 | 290132 | 4 | -2.72 | -5824 | -2 | -0.16 | 11874 | -649 | 9.44 |
| 359 | 290133 | 2 | -2.40 | -5827 | -2 | -0.09 | 11235 | -640 | 9.12 |
| 360 | 290132 | -0 | -2.09 | -5828 | -2 | -0.05 | 10597 | -631 | 8.77 |
| 361 | 290129 | -2 | -1.82 | -5830 | -2 | -0.07 | 9975 | -622 | 8.77 |
| 362 | 290124 | -4 | -1.58 | -5831 | -3 | -0.09 | 9362 | -615 | 8.27 |
| 363 | 290118 | -5 | -1.32 | -5834 | -2 | -0.08 | 8759 | -606 | 7.71 |
| 364 | 290112 | -6 | -1.08 | -5837 | -2 | -0.09 | 8162 | -598 | 7.07 |
| 365 | 290104 | -7 | -0.89 | -5840 | -2 | -0.02 | 7575 | -590 | 6.53 |
| 366 | 290097 | -7 | -0.71 | -5843 | -3 | -0.14 | 6990 | -584 | 5.83 |
| 367 | 290088 | -8 | -0.54 | -5844 | -3 | 0.05 | 6422 | -580 | 6.02 |
| 368 | 290080 | -8 | -0.40 | -5846 | -3 | -0.33 | 5853 | -576 | 6.27 |
| 369 | 290072 | -8 | -0.28 | -5849 | -2 | -0.41 | 5291 | -572 | 5.84 |
| 370 | 290062 | -9 | -0.16 | -5854 | -4 | -0.50 | 4718 | -570 | 6.25 |
| 371 | 290053 | -9 | -0.03 | -5856 | -2 | -0.85 | 4143 | -560 | 8.30 |
| 372 | 290044 | -8 | 0.02 | -5860 | -5 | -2.70 | 3572 | -549 | 13.27 |
| 373 | 290036 | -8 | 0.07 | -5858 | -6 | -3.51 | 3011 | -545 | 16.23 |
| 374 | 290028 | -8 | 0.11 | -5873 | -7 | -5.02 | 2445 | -533 | 20.33 |
| 375 | 290020 | -8 | 0.13 | -5862 | -10 | -7.10 | 1947 | -509 | 28.34 |
| 376 | 290013 | -8 | -0.09 | -5890 | -27 | -16.84 | 1478 | -460 | 47.49 |
| 377 | 290005 | -8 | -0.14 | -5897 | -35 | -21.13 | 945 | -430 | 58.91 |
| 378 | 289999 | -7 | -0.32 | -5910 | -48 | -28.68 | 492 | -389 | 75.29 |
| 379 | 289992 | -7 | -0.59 | -5946 | -68 | -39.71 | 133 | -315 | 99.06 |
| 380 | 289983 | -9 | -2.00 | -6100 | -154 | -86.10 | 0 | -133 | 181.95 |